BLOCK FAULTING IN THE KLAMATH LAKES REGION

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In the summer of 1915 the writer gathered some physiographic data of more than ordinary interest concerning block mountains in the Klamath Lakes region of Oregon; but because the data were based on hasty observations, he hesitated to publish them without further verification. The following winter, learning that Dr. G. K. Gilbert planned to visit parts of the Great Basin, I placed my notes at his disposal in the hope that he might verify the essential accuracy of some of my more hasty deductions. This he has done, and I make bold to place my observations on record. In doing so I apologize for the incompleteness of the data, but trust that the importance of the features observed will compensate in some measure for the paucity of description. I desire to express my appreciation of Dr. Gilbert's courtesy in permitting me to quote his confirmation of my general conclusions, and at the same time to acquit him of any responsibility for possible errors in the following statements. The region discussed is shown on the Ashland and Klamath topographic quadrangles of Oregon.

On emerging from the narrower portion of Anna Creek valley and entering the broadly open northern end of the Klamath Lakes basin, the observer is at once impressed with the topographic indications of block faulting. On the west is the east-facing scarp of the Cascade Mountains, not very imposing it is true, but remarkably straight and rising abruptly from the basin floor, strongly suggesting a fault scarp in the face of which a number of short streams have cut their valleys. The Crater Lake cone is seen to rest upon the northward continuation of the supposed fault fissure, while farther south another volcano, unnamed on the map, occupies a similar position. Such a distribution of volcanoes is rather suggestive in connection with the fault theory, and the

apparent continuation of the cone slopes unbroken into the basin indicates that in considerable part at least the eruptions followed the faulting. A mud flow from the Crater Lake volcano came recently enough to descend the already formed Anna Creek valley, and even to spread out over the floor of the basin for some distance if one may judge from topography alone. No sections were observed out in the basin, but farther up the valley Anna Creek

FIG. 1.—Joint structure in volcanic ash, Anna Creek valley. (Photo by D. W. Johnson.)

has trenched the flow, revealing a beautifully jointed ash deposit (Fig. 1). A sufficient number of lateral tributaries greatly to dissect the deposit has not yet been developed; partly, no doubt, because of the porosity of the ash.

On the east side of the Klamath basin is a lower scarp remarkable for its straightness and for the small extent to which it has suffered from the agents of erosion. It is far more youthful in appearance than the higher Cascade scarp. Because of its steepness the low, west-facing scarp is in striking contrast with the very gentle slope which declines eastward from its crest, and of

which one may catch an occasional glimpse from the automobile road. The topographic relations clearly indicate a very young block mountain with steep fault face on the west and gentle back-slope on the east. For convenience we may call this the "Fort Klamath block" from the little settlement of that name near the base of the west-facing scarp. The northern portion, at least, of the Klamath Lakes basin, bounded as it is by higher fault blocks on both the east and the west, would therefore appear to represent a graben, if this term may properly be applied to a relatively depressed block between two faults of different date. We will in any case refer to it simply as the "Klamath graben."

Toward the north the fault scarp of the Fort Klamath block appears to swing westward to intersect the Cascade scarp under the mass of the Crater Lake volcano. Indeed it would seem that the intersection of the two supposed fault fissures most probably lies beneath the surface of Crater Lake itself. Toward the south the Fort Klamath block dies out, to be replaced by the Modoc Point block described below.

One feature associated with the young Fort Klamath block deserves special attention. It is well understood that if a block mountain is raised across the path of a transverse stream so slowly that the stream is able to cut down its channel as fast as uplift occurs, the stream will maintain its antecedent course through the mountain. The transverse gorge of the Sevier River through the Cañon Range in Utah appears to be of this origin. On the other hand, if successive slight uplifts occur in too rapid succession, or if a single uplift is sufficiently great in amount, the river may be defeated in its purpose and turned aside. Somewhere, according to theory, we might reasonably expect to find one or more examples in which the river maintained its antecedent course for a long time, say until the block was raised halfway to its present altitude, but was then turned aside by a period of too-rapid uplift.

The Fort Klamath region seems to present just such a case. South of Fort Klamath settlement one sees from the automobile road what at first appears to be a hanging valley opening in the face of the fault scarp about halfway between crest and base

(Fig. 2). From a distant view one gets the impression, however, that the elevated valley floor slopes eastward, or away from the fault scarp instead of toward it. I interpreted this to mean that a stream formerly flowed from west to east through the block, probably to unite with Williamson River, and that it maintained its antecedent course until half the present altitude of the rising block had been attained; then an excessive uplift dammed the stream and turned it southward along the Klamath graben, while the deserted valley was later raised to its present altitude by continued uplift of the range. Regarding this remarkable valley Dr. Gilbert writes: "The hanging valley you noted seems to be the only one of its type. I was able to verify your interpretation."

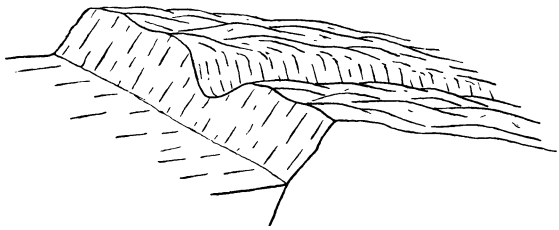

FIG. 2.—Deserted antecedent gorge in uplifted lava block south of Fort Klamath settlement.

In this connection I may perhaps refer to another possible example of the same physiographic type, recorded more than ten years ago, but not described in print because of the hasty character of the observations on which my tentative interpretation was based. In the summer of 1906 I passed through the Parowan Valley at the western base of the high plateaus of Utah. This depression (Fig. 3) is well shown on the Kanab topographic quadrangle, and was interpreted as a graben similar to the one described above. The great fault which bounds the valley on the southeast is abundantly attested by both physiographic and stratigraphic evidence, as I proved by several traverses across the fault southeast of Summit, Parowan, Paragoonah, and elsewhere. On the northwest the valley floor terminates abruptly at the base of a pronounced scarp, which is more or less dissected, but which shows occasional well-marked triangular facets such as characterize the fault faces

of certain block mountains. The topography strongly suggests that Parowan Valley is a down-dropped block, bounded on the southeast by a fault-block plateau and on the northwest by a fault-block mountain whose more gentle back slope is toward the northwest.

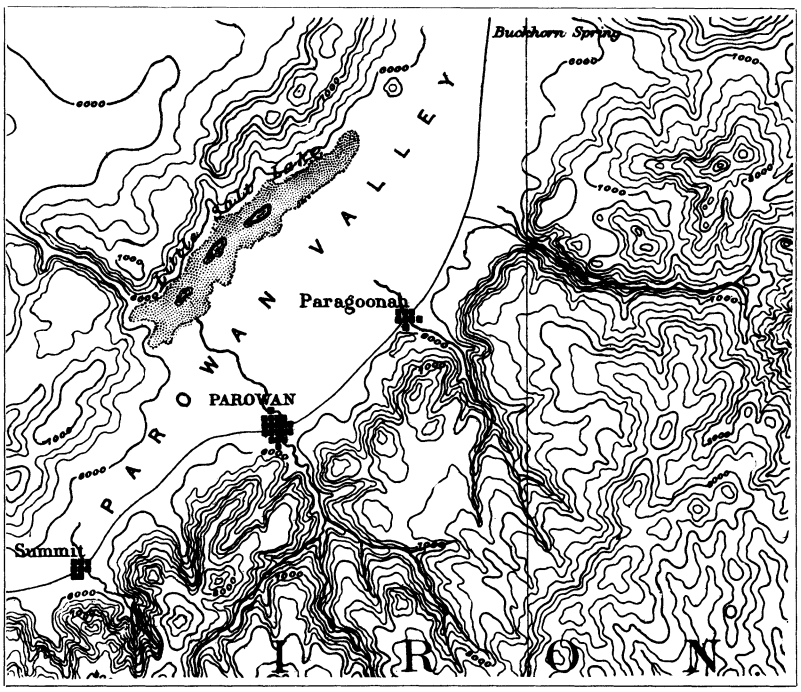

FIG. 3.—The Parowan graben, Utah, showing abandoned antecedent gorge through block mountain on the northwest.

Cutting transversely through the block mountain just mentioned is a remarkable gorge directly in line with the extended lower course of a stream which rises in the block plateau and flows northwest through the town of Parowan. According to the map, however, the stream does not continue through the gorge at the present time, but terminates in a salt lake at the base of the fault scarp. The topographic relations suggested the possibility that a recent upfaulting of the block mountain had obstructed the Parowan stream and left the antecedent gorge deserted. If this be the

correct interpretation the case is of interest as representing an earlier stage of the history recorded in the Fort Klamath example; for in the Parowan case the deserted valley has not yet been raised much above its former level, and the lake initiated by the rising obstruction has found no new outlet. It is possible that heavy rains might so raise the lake-level as to cause it to spill out through

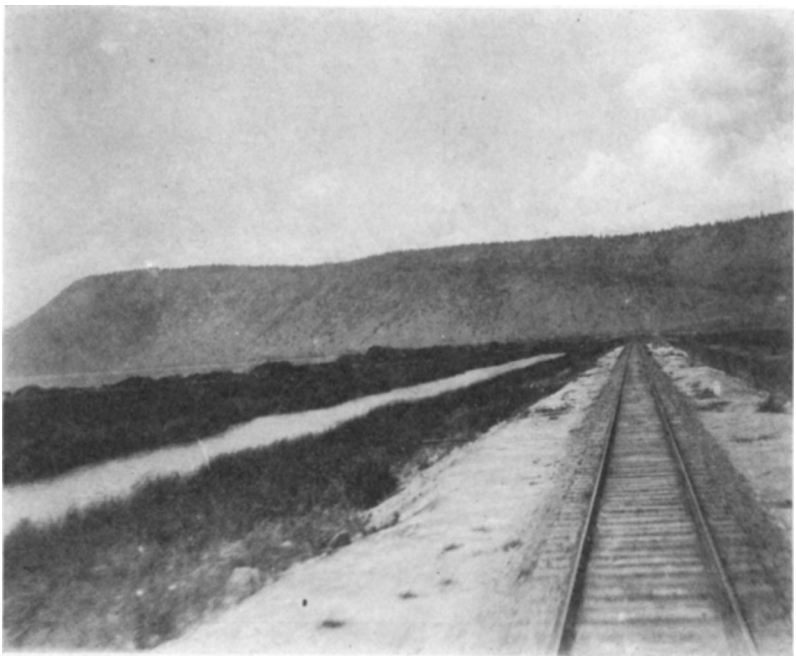

FIG. 4.—Fault-block "splinter" on face of young block mountain. Modoc Point looking north from Plum Ridge. (Photo by A. K. Lobeck.)

the gorge itself before another outlet was found. Unfortunately I was not able to visit the entrance to the gorge, nor otherwise to test the validity of my tentative interpretation. Observations based on a reconnaissance map with contour interval of 250 feet, supplemented by visual inspection from a distance of four or five miles, must not be accorded too high a value.

Returning to the Klamath graben we may note that from Cihloquin southward a very young fault scarp forms the imposing

east wall of the graben. This is the western face of what may be called the Modoc Point block mountain, which stands in the same relation to the graben as the Fort Klamath block farther north, and, like the latter, has a more gentle eastern back slope. The west-facing fault scarp is remarkable for its youthful appearance, erosion having modified it but slightly, and for the straightness of its base line for many miles at a stretch. At Modoc Point itself the strike of the fault changes rather abruptly from N.–S. to S. 35 E.

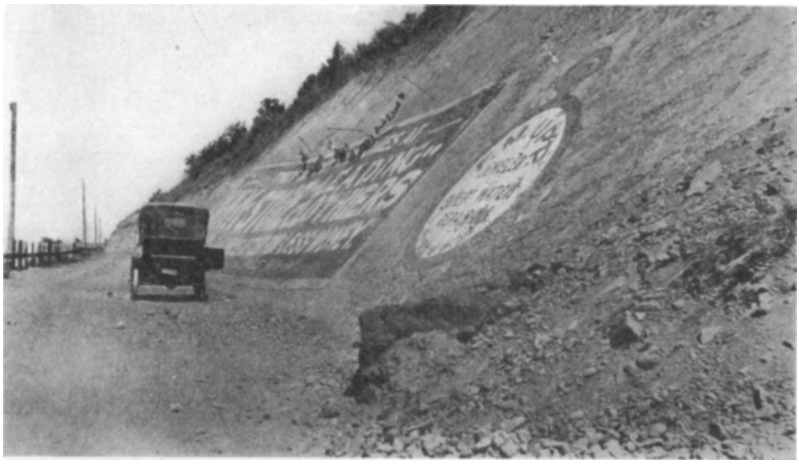

FIG. 5.—Slickenside surface exposed along road cut in north end of Plum Ridge. (Photo by J. P. Buwalda.)

On the face of the range farther south is a prominent "fault-block splinter," clearly shown in Fig. 4, from a photograph of Modoc Point looking northward from the northern end of Plum Ridge. The same view illustrates the youthful character of the fault scarps.

It must not be supposed that the back slopes of the Fort Klamath and Modoc Point blocks are as smooth and featureless as their fault faces. Both blocks are remarkably youthful in the present cycle of erosion, as the descriptions of their fault scarps fully indicate; but no description would be complete which did not include an account of the stage of erosion reached in the pre-faulting cycle, as indicated by the topographic aspect of the back slopes. Our route of travel gave little opportunity for observation

on this point; but it may be said that both the contours of the Klamath topographic quadrangle and such glimpses as we secured of the back slopes agree in suggesting that the prefault topography was moderately rugged. The back slope of neither block appears to be as featureless as it would be had the region subjected to faulting consisted of a young lava plain on the one hand, or, on the other hand, of a volcanic region reduced by long-continued erosion to a peneplain. Dr. Gilbert writes that the reconstruction of the prefaulting relief would be a difficult task, because the great blocks have been "intricately sliced and dislocated on a small scale; and one of the marvelous features of the region is the association of major faulting with elaborate contemporaneous minor faulting."

West of the southern end of the Modoc Point block is a subsidiary fault block called Plum Hills or Plum Ridge. Near the northern end of the steep, undissected scarp which bounds this ridge on the west there is a magnificent exhibition of slickenside surfaces visible from the passing train. Here we have preserved that rare phenomenon, a portion of the actual fault plane of a fault-block mountain. The perfection of the slickenside surfaces may be inferred from the fact that one of them has been used as a "bill board" upon which are painted the advertisements of certain business houses, as shown in Fig. 5.